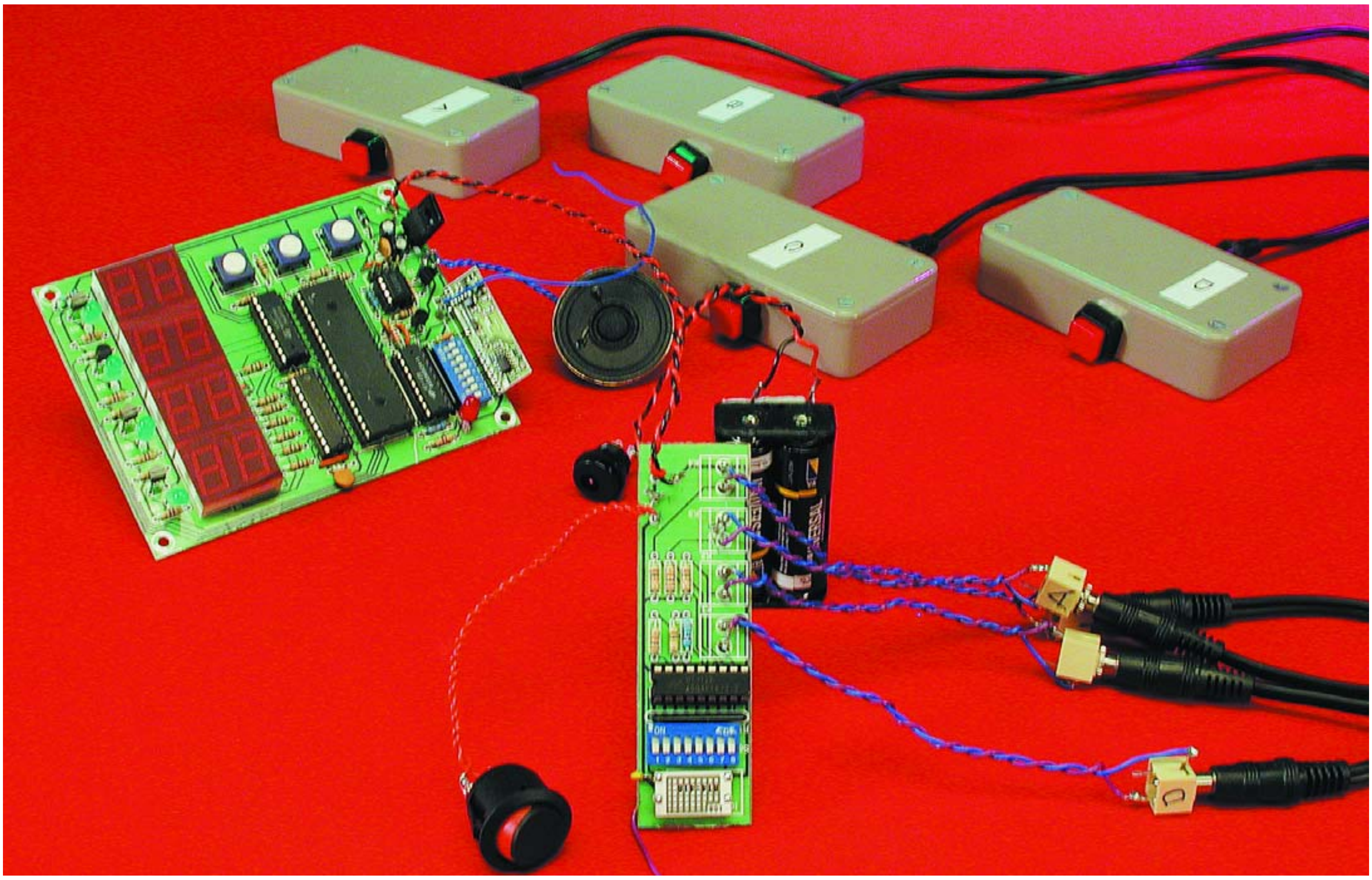
Quizmaster

radio-linked!

By Andy & Rose Morrell

The Quizmaster described here is a four-player version with an extra player to operate the 'box' and to ask the questions etc. No wiring required between the player and quizmaster desks!



Knowledge-based quizzes of the 'University Challenge' variety are extremely popular, and have spawned many derivates that can be seen on TV every day. Where many people would be perfectly capable of organizing a quiz, persuading players and a quizmaster to participate, drawing up a list of questions (geared to the contestants' specific interest or level of education) and arrange a suitable venue, alas, building a 'machine' to detect the first key press, display the score, etc. often poses insurmountable problems. The present design should be easy to build by anyone with reasonable skills in DIY electronics.

One of the major problems in mimicking a quiz 'studio' is the cabling. The Quizmaster project discussed here overcomes that difficulty by means of a wireless link between the contestant desks and the quizmaster desk.

Here's how the system works. Immediately after the quizmaster asks the question he/she presses the start timer button. The player who hits his/her button first will instantly lock out the other three so further presses of the buttons by any of the other contestants will have no effect. To indicate which player was first, that player's LED flashes and a siren is heard.

If none of the players press their button, a timeout will be reached in approximately 10 seconds. The four LEDs will then start to flash simultaneously until the quizmaster presses the button labelled 'reset timer'.

If the correct answer is produced by one of the players, all the quizmaster has to do is press the 'correct' button to add 1 to their score, or the 'wrong' button, which obviously leaves the score unaltered. Then, the next question is asked.

The Quizmaster project offers ease of use for players as well as the quizmaster, which allows everybody to concentrate on the questions, which is essential for the overall success of the quiz if an audience is present. The quiz night at the local pub is another, hopefully hilarious, matter.

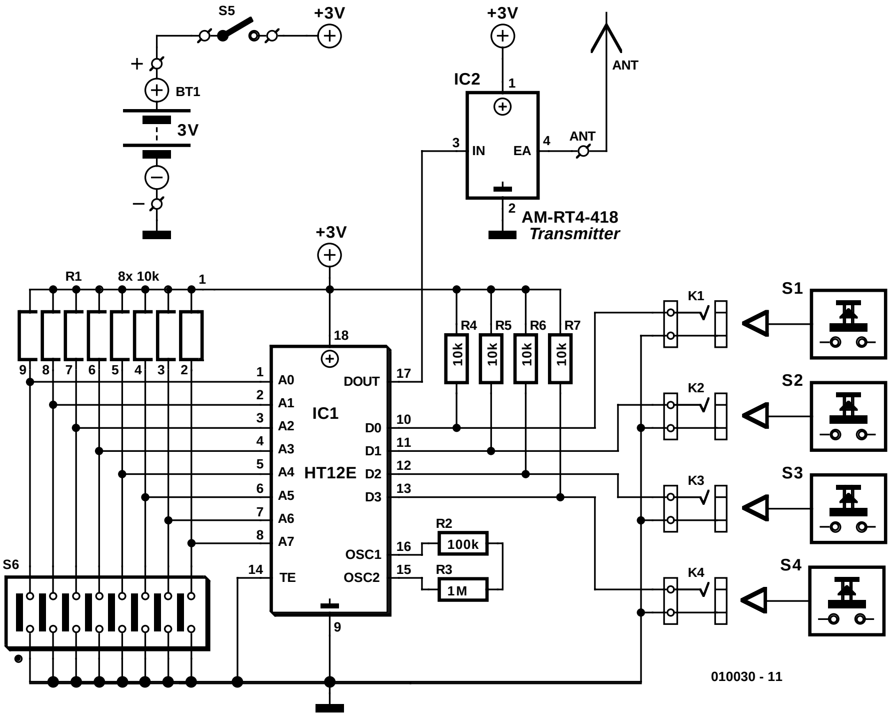


Figure 1. Circuit diagram of the Quizmaster central transmitter to be fitted in or near the players' desk.

How it works

Just as the transmitter and receiver unit discussed further on, two other components in the circuit are always encountered as a 'pair'. The HT12D and HT12E integrated circuits from Holtek have been used in a previous *Elektor Electronics* project, see 'Radio-Linked Caller ID' System in the January 2001 issue. Datasheets may be found at the manufacturers' website [1]. The circuit diagram of the transmitter does not amount to much, see **Figure 1**.

The HT12E encoder chip, IC1, has its four inputs D0-D3 connected to four pushbuttons in small individual boxes via 2.5-mm jack sockets and leads. The HT12E has its transmit enable (TE) pin wired to ground so it is constantly transmitting when the power is on (this will not affect the receiver). The whole transmitter/encoder circuit runs off two AAA or AA batteries. The output of the encoder chip is wired to the 418 (or 433) MHz transmitter which operates a good range on the same 3-V battery set. A 17-cm (7 inch) length of wire is used for a quarter-wave aerial.

The (one-way) communication between the HT12E and HT12D is encoded. The same 8-bit code (word) has to be set on the DIP switch blocks (S5, S6) for the receiver to recognize the transmitter.

All of the intelligence required to control the Quizmaster circuitry is crammed into a single microcontroller of the PIC variety. As you can see from the receiver circuit diagram in **Figure 2**, not much is needed to enable the PIC to handle all input/output functions, where 'input' really means reading data from the 433-MHz receiver and scanning the quizmaster's desk buttons, while 'output' boils down to enabling the siren and driving the LED indicators and displays. A run-of-the-mill 5-volt power supply completes the circuit.

Pressing the START button allows the PIC to recognise if the HT12D receiver chip receives a signal from player A to D. The PIC chip updates a software counter by interrupt every millisecond or so. If no data is received from the central transmitter, (i.e., none of the players knows the answer to the question) the counter will produce a timeout after about 10 seconds. The PIC will then flash all four LEDs labelled Player A-D (D3-D6) until the quizmaster presses the WRONG/RESET button.

When the correct answer is produced within the available time slot of about 10 seconds, the quizmaster will press the CORRECT button. The siren chip, IC6, fits in perfectly for the sound. PIC pin port line RD7 is pulled low, and via the BC327 PNP transistor (T5) turns on the UM3561 siren chip. A BC548 transistor at the UM3561 output enables a small 64-Ω loudspeaker to be driven so that the siren sound is clearly heard. Three popular siren sound types are available and may be selected by switch S4.

As already mentioned, communication between the player's desk(s) and the quizmasters desk is wireless. Here, a low-cost licence-exempt transmitter/receiver pair from RF Solutions is used. The units originally used by the authors operate in the 418 MHz band. Licence-exempt means that the transmitter can be used freely by anyone as long as it is not modified or connected to a directional antenna. The transmitter and receiver may also be 433-MHz versions since in the UK 433.92 MHz is also allocated for short-range licence-exempt communications. The use 433.92 MHz band has been harmonized across Europe, and it is expected that the

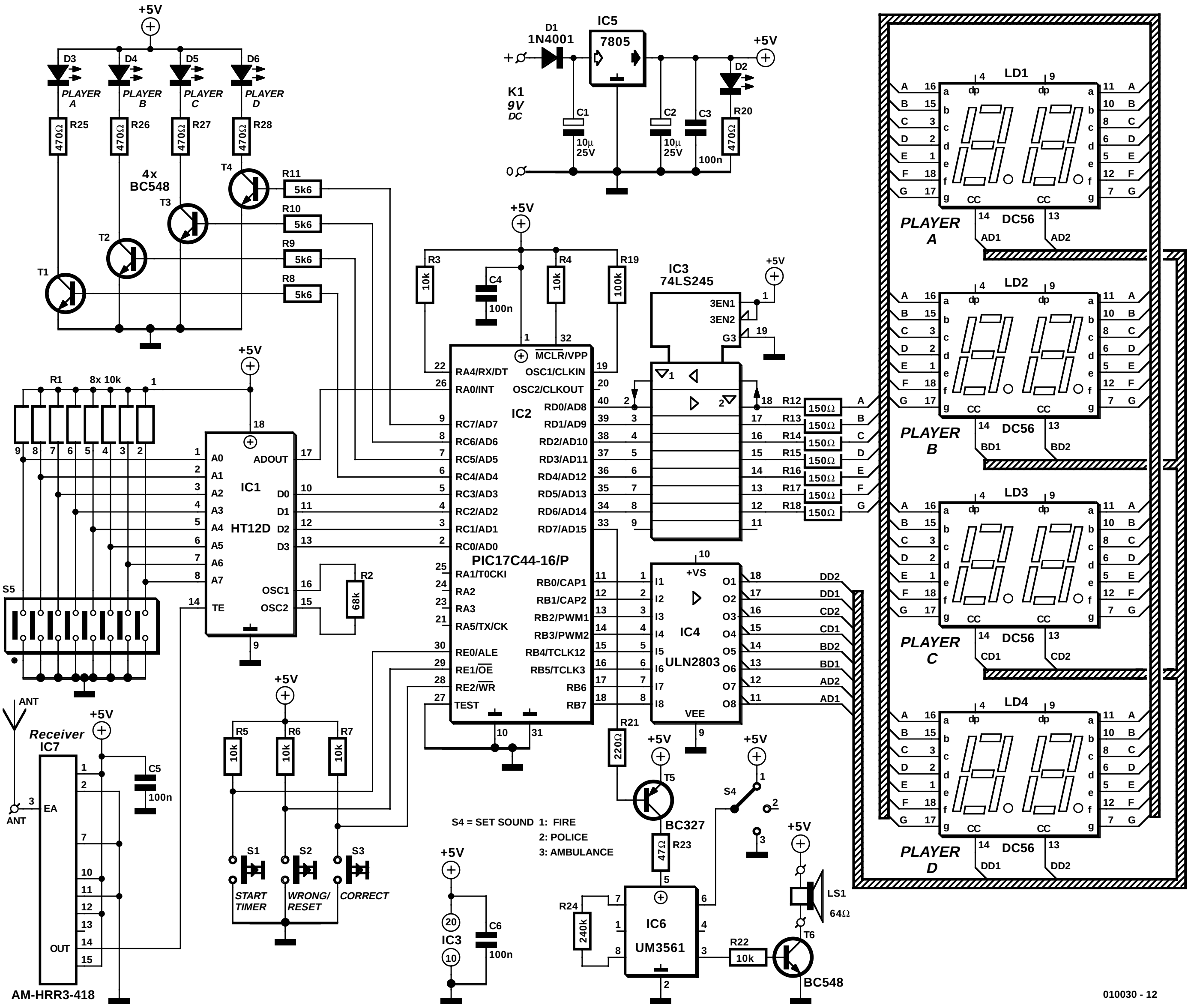


Figure 2. Circuit diagram of the Quizmaster central receiver. With a PIC in control, hardware is down to a minimum!

418 MHz allocation will be gradually phased out in the UK. Datasheets of the AM-RT4-418/433 and AM-HRR3-418/433 may be found on the Internet [1].

Returning to the main unit installed in the quizmaster's desk, the PIC17C44 chip drives the display units in multiplex mode via two driver ICs, a ULN2803 for the common-cathode (CC) lines and a 74LS245 for the digit (anode) lines. There are four 2-digit 7-segment displays. Four BC48 transistors (T1-T4) drive the 5-mm 'Player' indicator LEDs.

To close off the discussion of the circuit operation, the power supply is conventionally based on a 7805 3-pin voltage regulator that steps down the unregulated DC input voltage (max. 9 V) at K1 to 5 V as required by the receiver circuitry. LED D2 acts as the on/off indicator. In view of electrical safety we recommend the use of a mains adaptor with an output current rating of about 300 mA or better.

The control program

Since the source code file for the program that runs inside the PIC is far too large to print in this article, it available either on floppy disk, order code **010030-11** (at a nominal charge), or as a free download from the *Elektor Electronics* website at www.elektor-electronics.co.uk. If you have a suitable PIC assembler, you may decide to use the assembly code file to generate your own object code and burn your own PIC17C44 for this project. The commented lines should be easy to understand, and represent educational value even if you do not intend to build the Quizmaster. A ready-programmed PIC is also available from the Publishers, the order code is **010030-41**.

Construction

The transmitter and the main unit are built on printed circuit boards of which the layout is shown in Figure 3. Note that the two boards have to be separated by cutting. The photographs in Figures 4, **5** and **6** give a good idea of how the boards should be stuffed.

The receiver board contains all components including the displays, and may have to be mounted in a position where the readout (score displays and Player LEDs) can be clearly seen by everyone. This may necessitate fitting the quizmaster's control buttons off the board and on a separate little panel.

We recommend using sockets for all ICs on the boards. In particular the programmed PIC represents considerable value!

The transmitter and receiver antenna are both 17-cm long pieces of straight wire which for optimum radiation (transmitter) and reception (receiver) should not be enclosed in a metal case.

Voltage regulator IC3 will not run excessively hot but to remain on the safe side you may still decide to fit it with a small heatsink.

The 64-Ω loudspeaker may be mounted in an external box or, space allowing, in the central receiver case.

Any code word you like may be used to

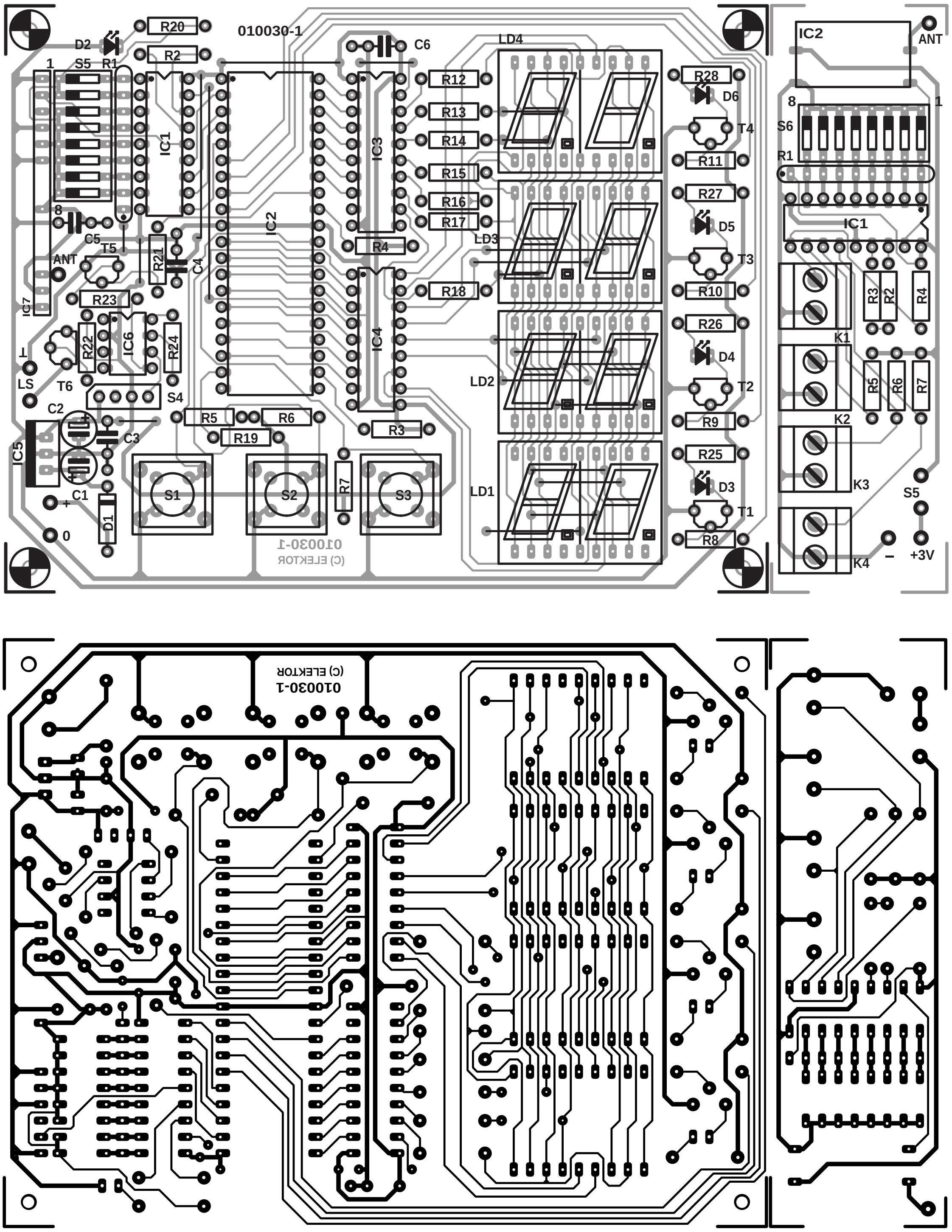


Figure 3. Copper track layout and component mounting plan of the combined receiver & transmitter board (separate by cutting, before populating). This board is available ready-made.

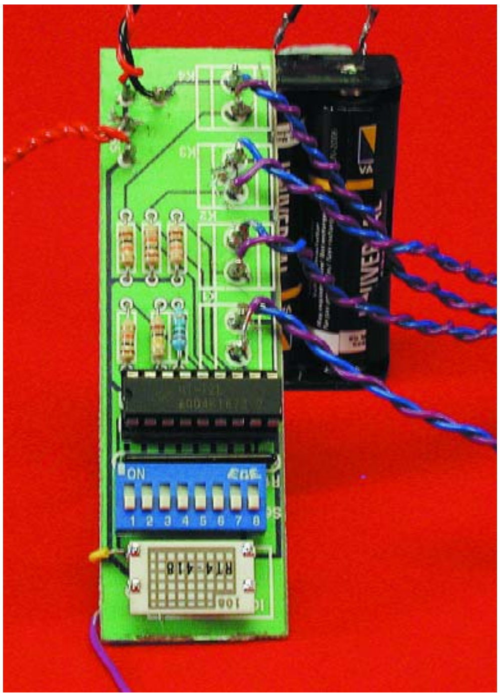


Figure 4. Completed transmitter board.

encode the transmitter, as long as you (1) set the same word on the receiver and (2) the code word is exclusive to other transmitters in an area of about 300 m.

(010030-1)

Web Addresses

[1] HT12E/HT12D datasheets: www.holtek.com.tw

[2] AM-HRR3-418/433 and AM-TR-418/433 datasheets: www.rfsolutions.co.uk

COMPONENTS LIST
Transmitter

Resistors:

R1 = 8-way 10kΩ SIL array
R2 = 100kΩ
R4..R7 = 10kΩ
R3 = 1MΩ

Semiconductors:

IC1 = HT12E (Farnell # 562415)
IC2 = AM-RT4-433 (RF Solutions)*

Miscellaneous:

K1-K4= jack socket, 2.5mm, mono, PCB mount
S1-S4 = pushbutton (external), 1 make contact
S5 = on/off switch
S6 = 8-way DIP switch
BT1 = 3-V battery with holder (or 2 off AA/AAA battery)

Receiver

Resistors:

R1 = 8-way 10kΩ SIL array
R2 = 68kΩ
R3-R7,R22 = 10kΩ
R8-R11= 5kΩ6
R21 = 220Ω
R12-R18 = 150Ω
R19 = 100kΩ
R20 = 470Ω
R23 = 47Ω
R24 = 240kΩ
R25-R28=470Ω

Capacitors:

C1,C2 = 10µF 16V
C3-C6 = 100nF

Semiconductors:

D1 = 1N4001
D2-D6 = LED, green, 5mm dia.
IC1 = HT12D (Farnell # 563250)
IC2 = PIC17C44-16/P, programmed, order code **010030-41**
IC3 = 74LS245
IC4 = ULN2803AP (Farnell # 3187032)
IC5 = 7805
IC6 = UM3561 (UMC) (Rapid Electronics # 82-0704, tel. 01206 751166)
IC7 = AM-HRR3-433 (RF Solutions) *
LD1-LD4= 2-digit 7-segment LED display, common cathode, e.g., Kingbright DC56-11EWA
T1-T4,T6 = BC548
T5=BC327

Miscellaneous:

K1 = mains adaptor socket, PCB mount
S1,S2,S3= pushbutton, 1 make contact, type CTL3 (Multimec) or DR-6
S4 = 3-way 1-pole switch
S5 = 8-way DIP switch
LS1 = 64Ω loudspeaker
PCB, order code **010030-1** (combined board for receiver and transmitter)

* 433 MHz transmitter/receiver modules available as a pair from Maplin, order code VY48C.

Figure 5. Completed receiver board. ▽

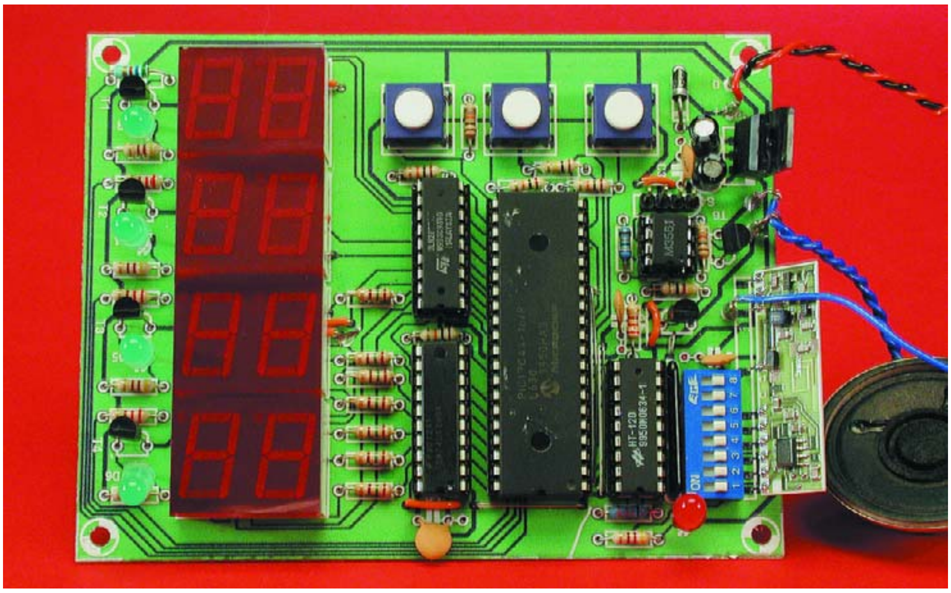


Figure 6. Close-up of the RF Solutions AM-HRR3-433 radio receiver module fitted on to the main board. ▷